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Goeller

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(54) **PERPETUAL CALENDAR WITH A DIFFERENTIAL MECHANISM**

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G04B 19/253 (2006.01)

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CPC ***G04B 19/24*** (2013.01); ***G04B 1/00*** (2013.01); ***G04B 19/2536*** (2013.01)

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See application file for complete search history.

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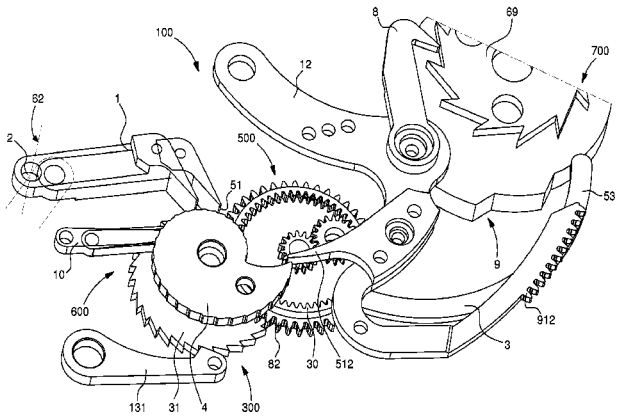
(57) **ABSTRACT**

A perpetual calendar for a watch including a movement controlling the daily release, at the moment that the date changes, of a mechanism actuating a perpetual lever of this perpetual calendar is disclosed. The perpetual calendar includes a calendar mechanism, a daily countdown mechanism including a month-end adjustment mechanism, and a differential mechanism. The calendar mechanism is arranged to determine the duration of the current month and is updated at each current month change by the daily countdown mechanism. The differential mechanism is arranged to control, each day at the moment that the date changes, the motion of an additional adjustment cam comprised in the month-end adjustment mechanism, based on the current day of the month taken from the daily countdown mechanism, and also based on the current month duration taken from the calendar mechanism.

8 Claims, 10 Drawing Sheets



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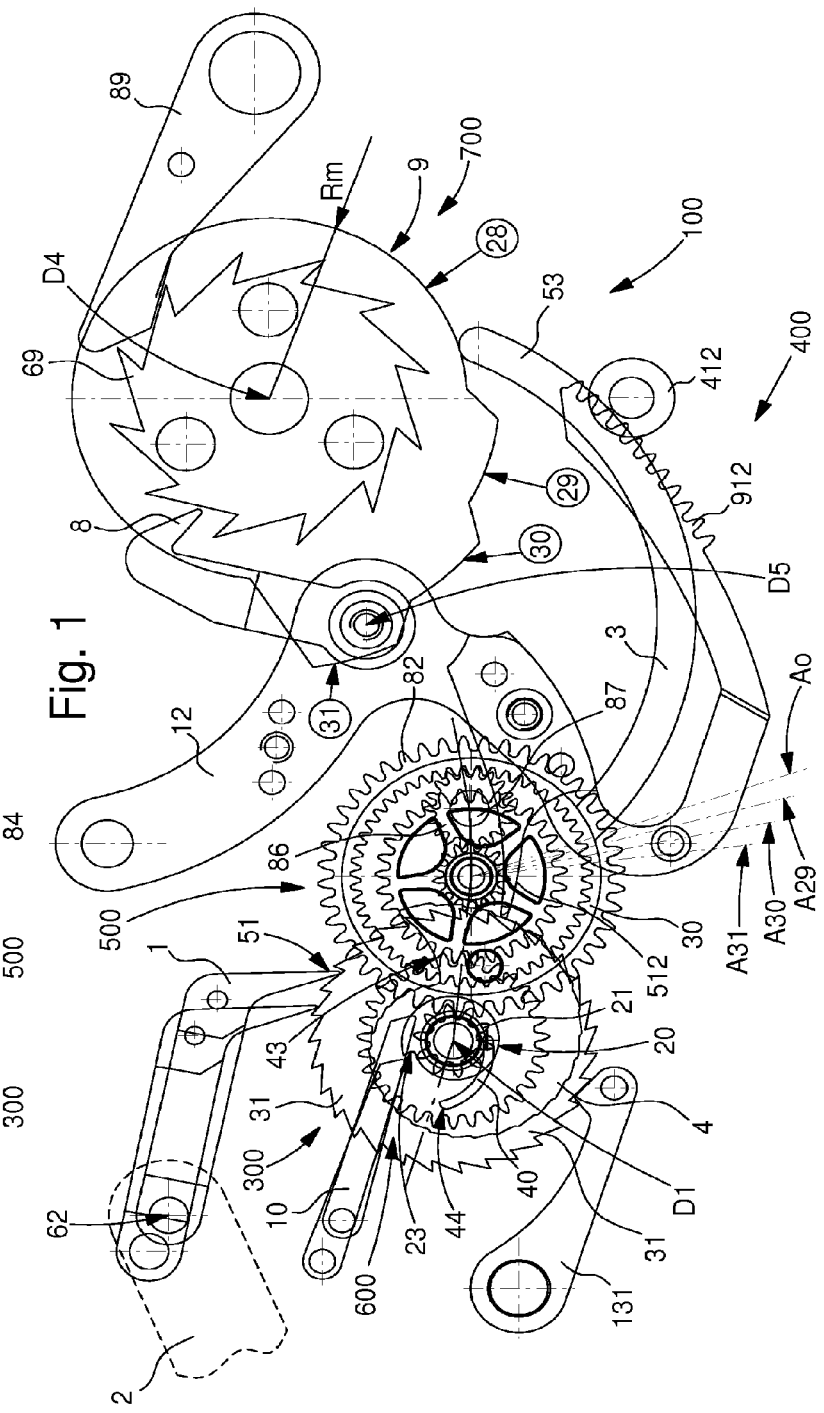

89
Rm
9
700
28
100
D4
53
69
412
400
912
8
29
30
D5
3
82
87
Ao
12
31
86
500
1
51
512
30
A31
A30
A29
43
21
20
4
31
300
10
62
23
44
40
D1
600
131
2

Fig. 1

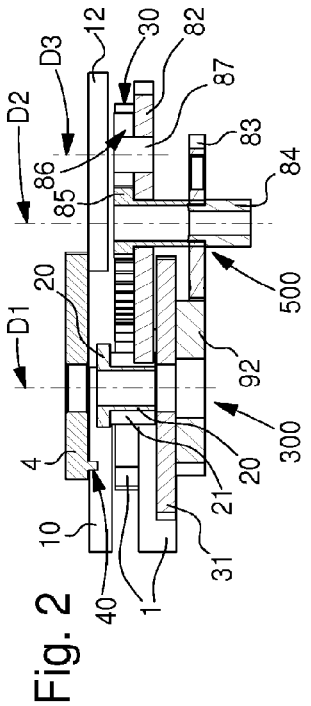

D2
D3
12
30
82
87
83
84
86
85
500
D1
20
92
300
4
10
21
20
31
40
1

Fig. 2

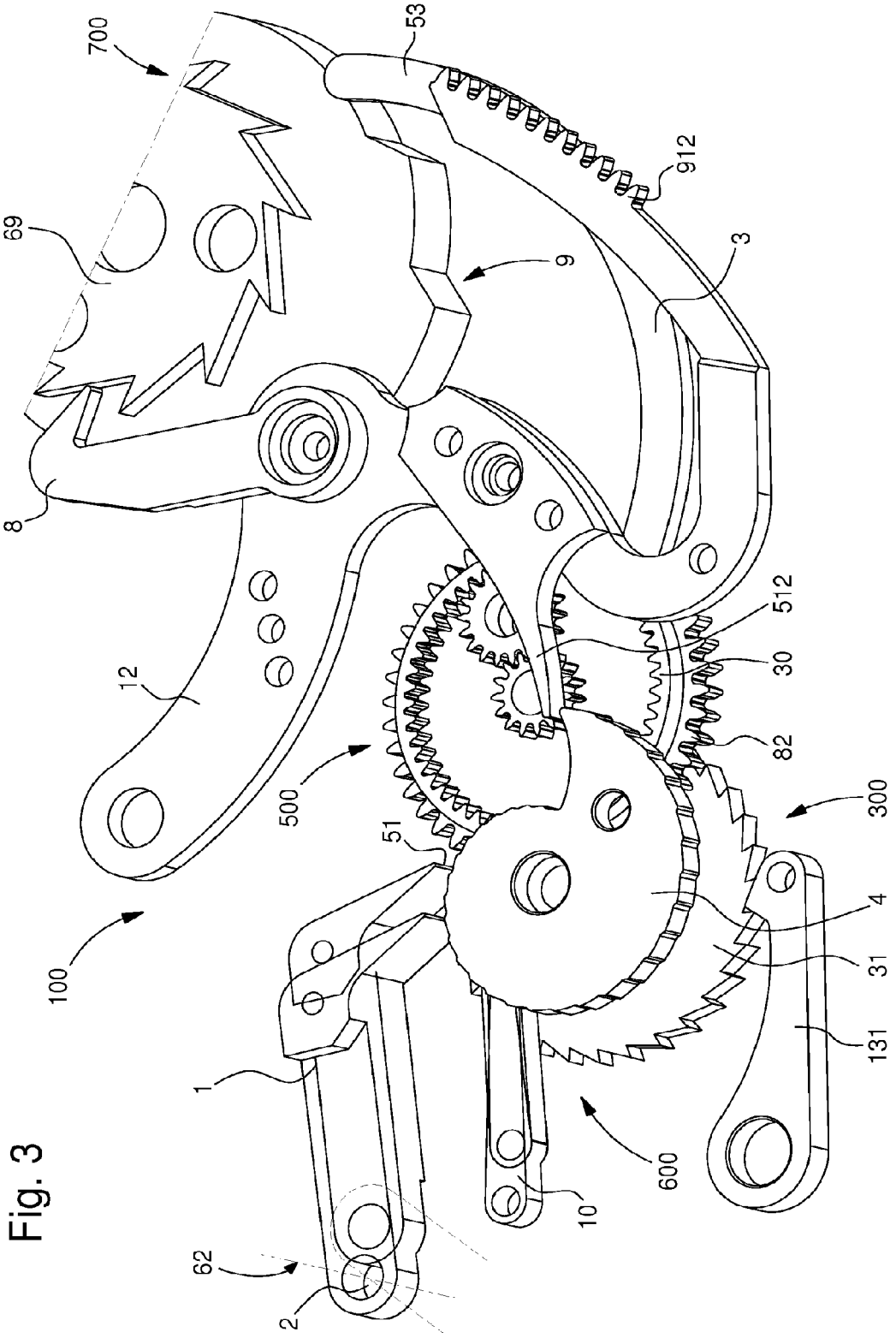


Fig. 3

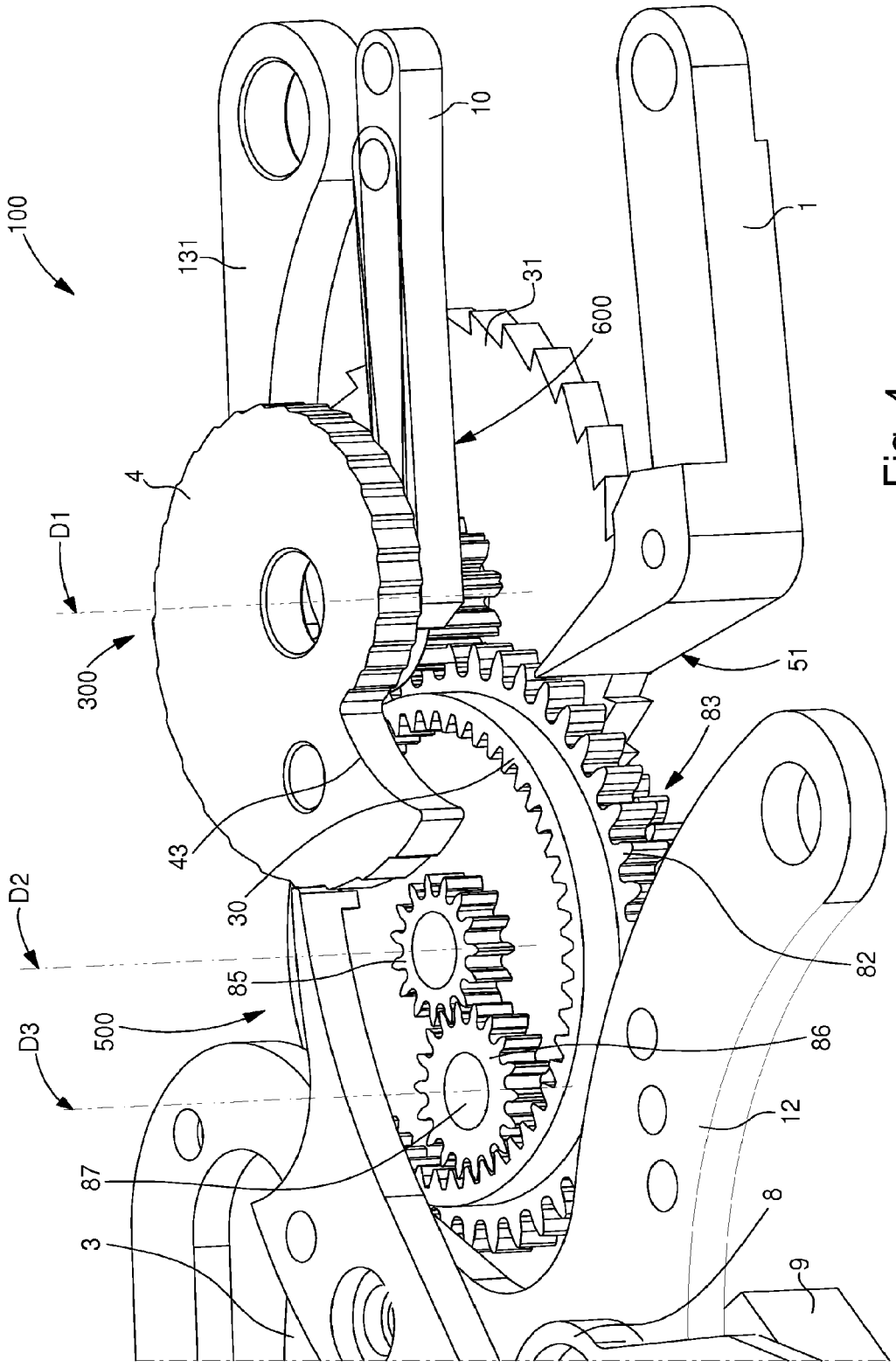


Fig. 4

Fig. 5

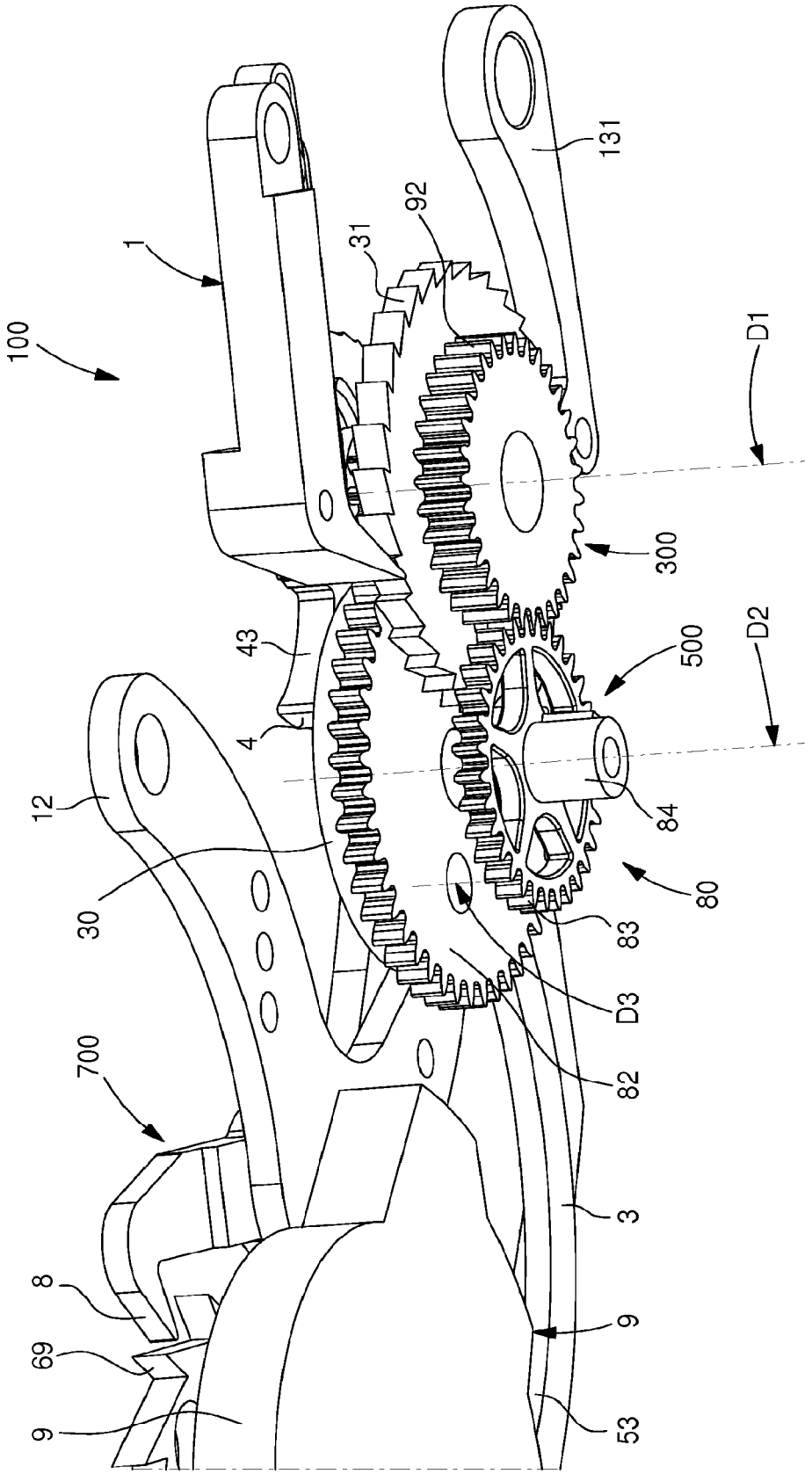


Fig. 6

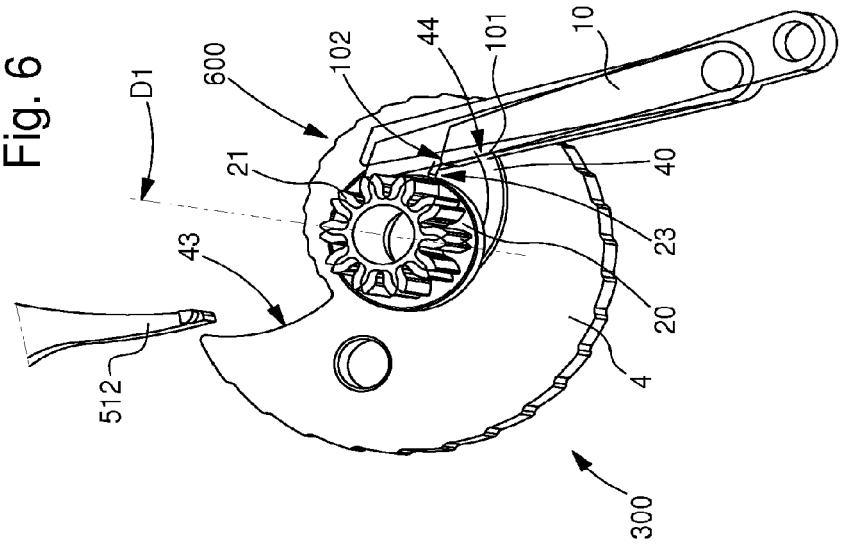


Fig. 13

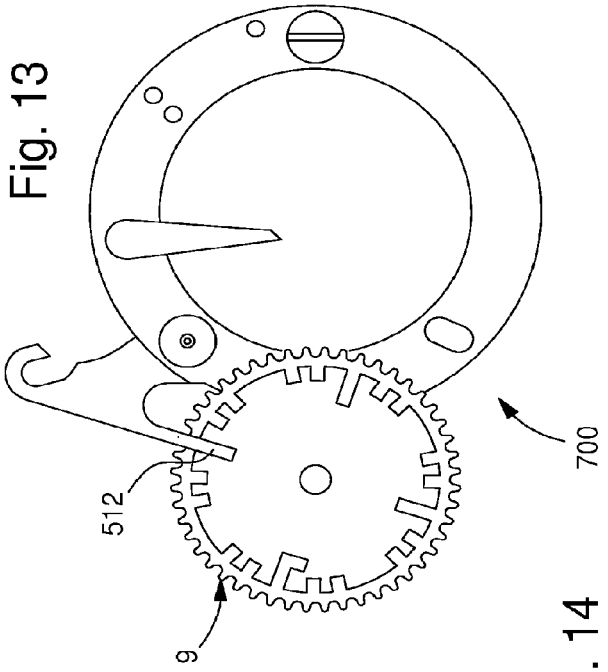
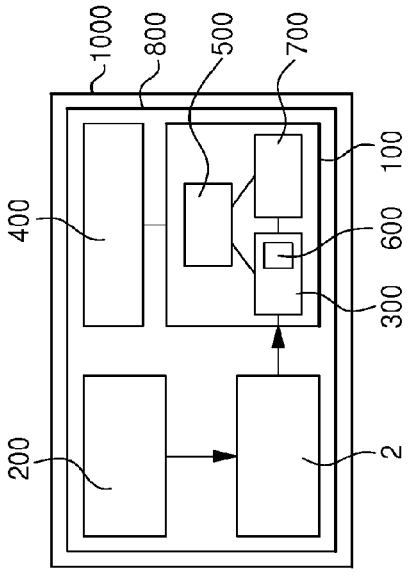


Fig. 14



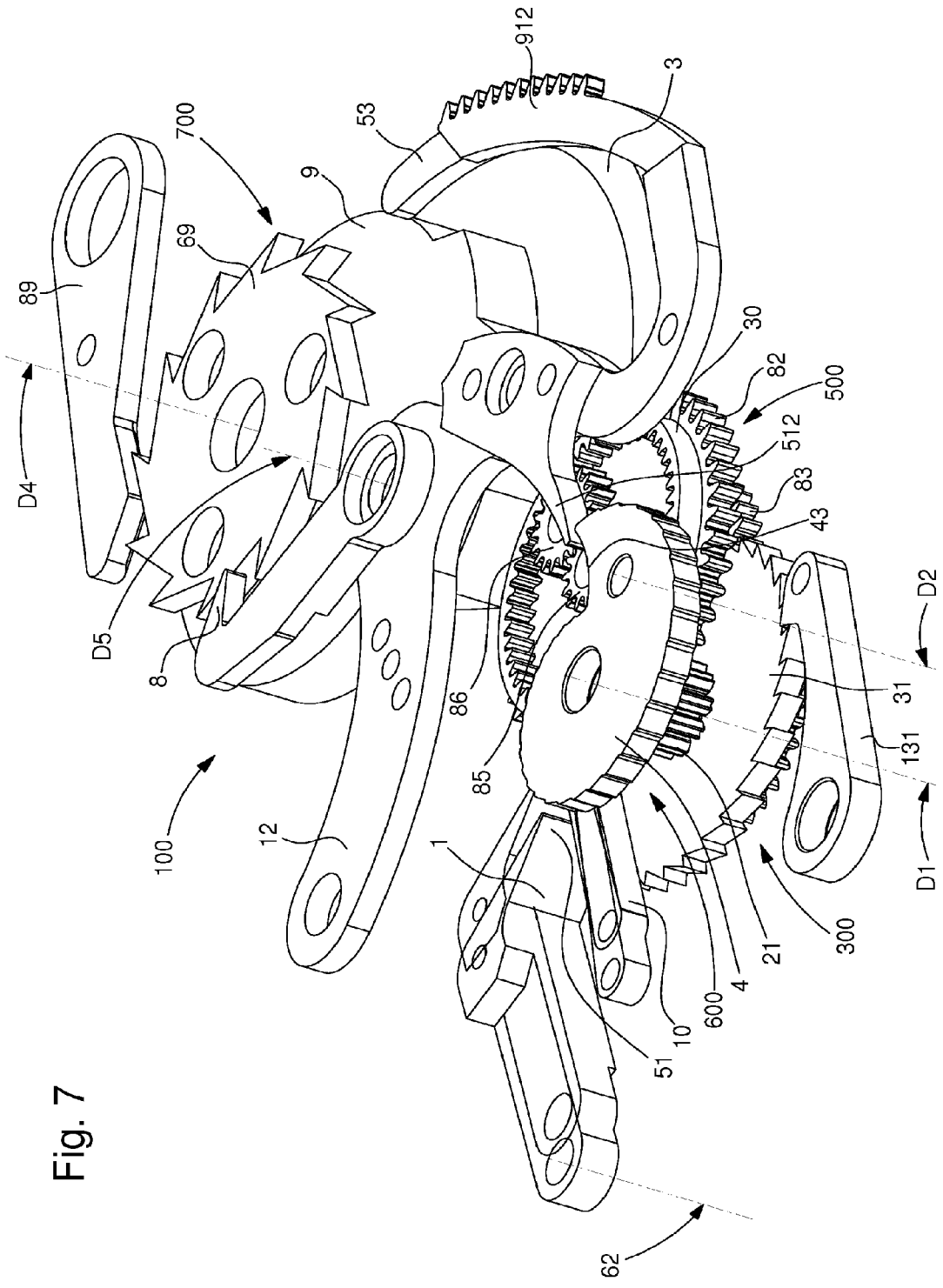

912
3
53
700
9
69
89
30
82
500
512
83
43
D4
D5
8
86
85
D2
31
131
D1
100
12
1
51
10
600
4
21
300
62

Fig. 7

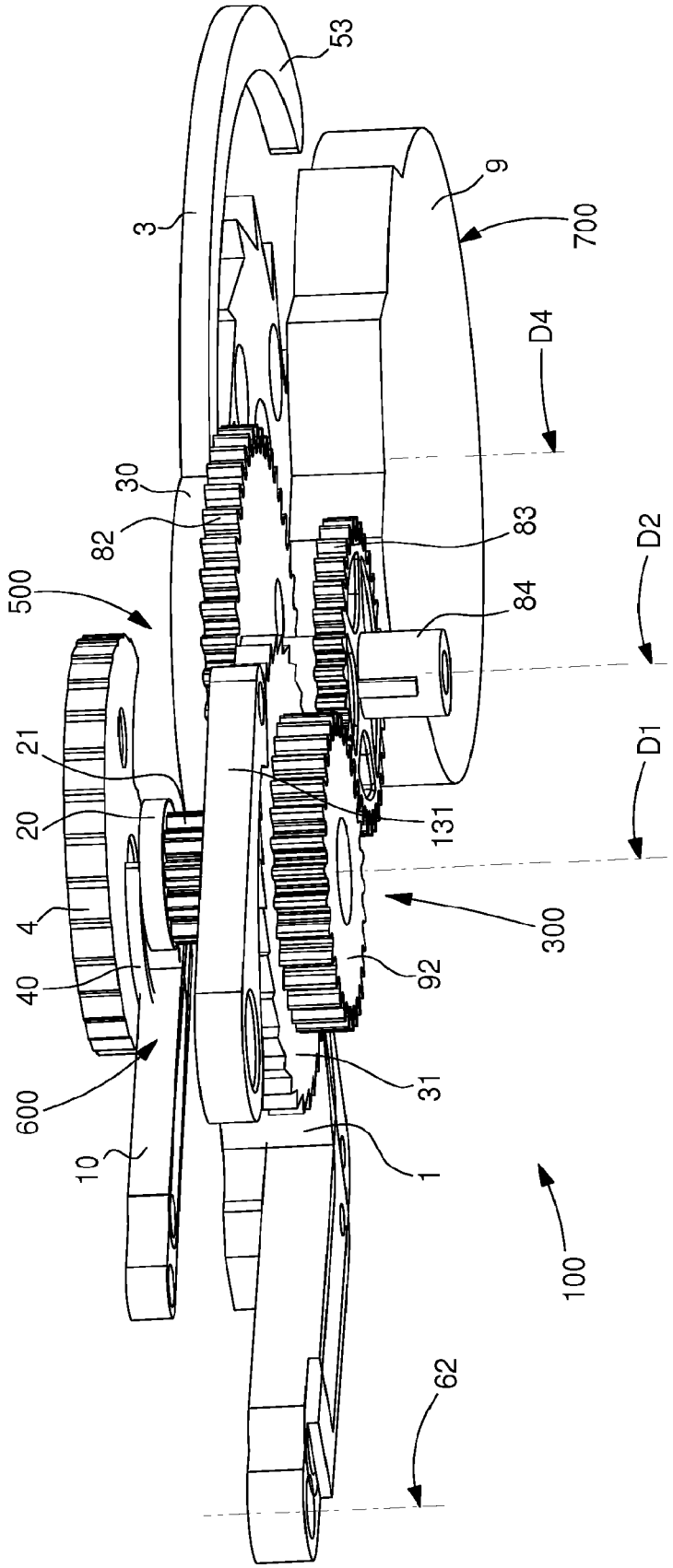

53
9
3
700
D4
30
82
83
D2
500
84
21
D1
20
131
4
300
40
92
600
31
10
1
100
62

Fig. 8

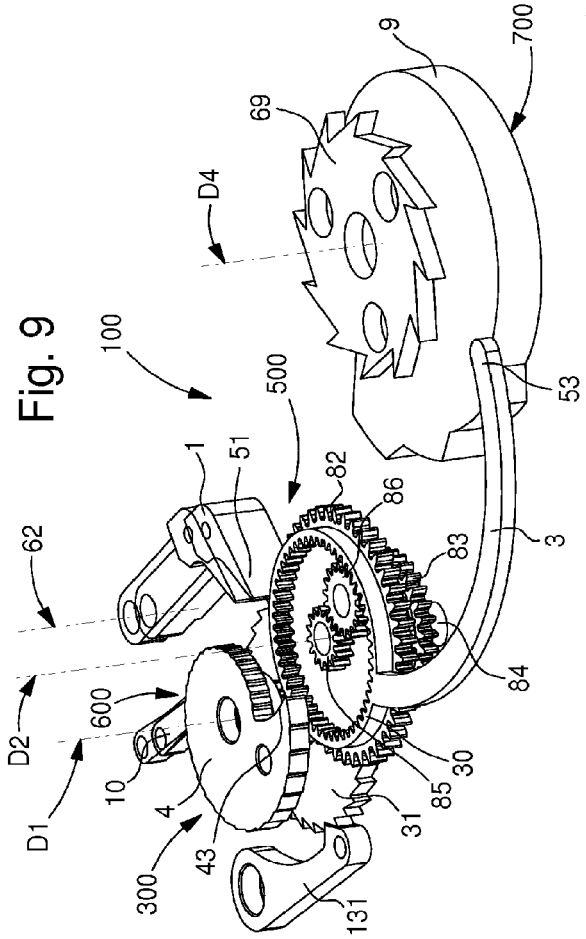


Fig. 9
100
500
700
9
69
D4
53
3
1
51
82
86
83
62
84
D2
600
10
4
D1
30
85
31
43
300
131

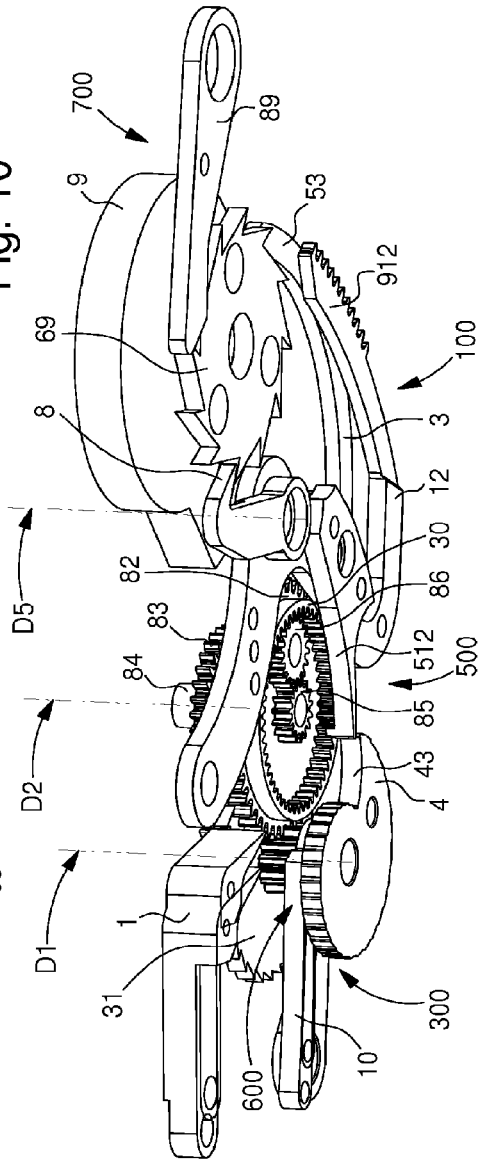


Fig. 10
700
89
9
53
912
69
100
8
3
12
30
D5
82
86
83
512
500
84
85
D2
43
4
D1
1
31
600
10
300

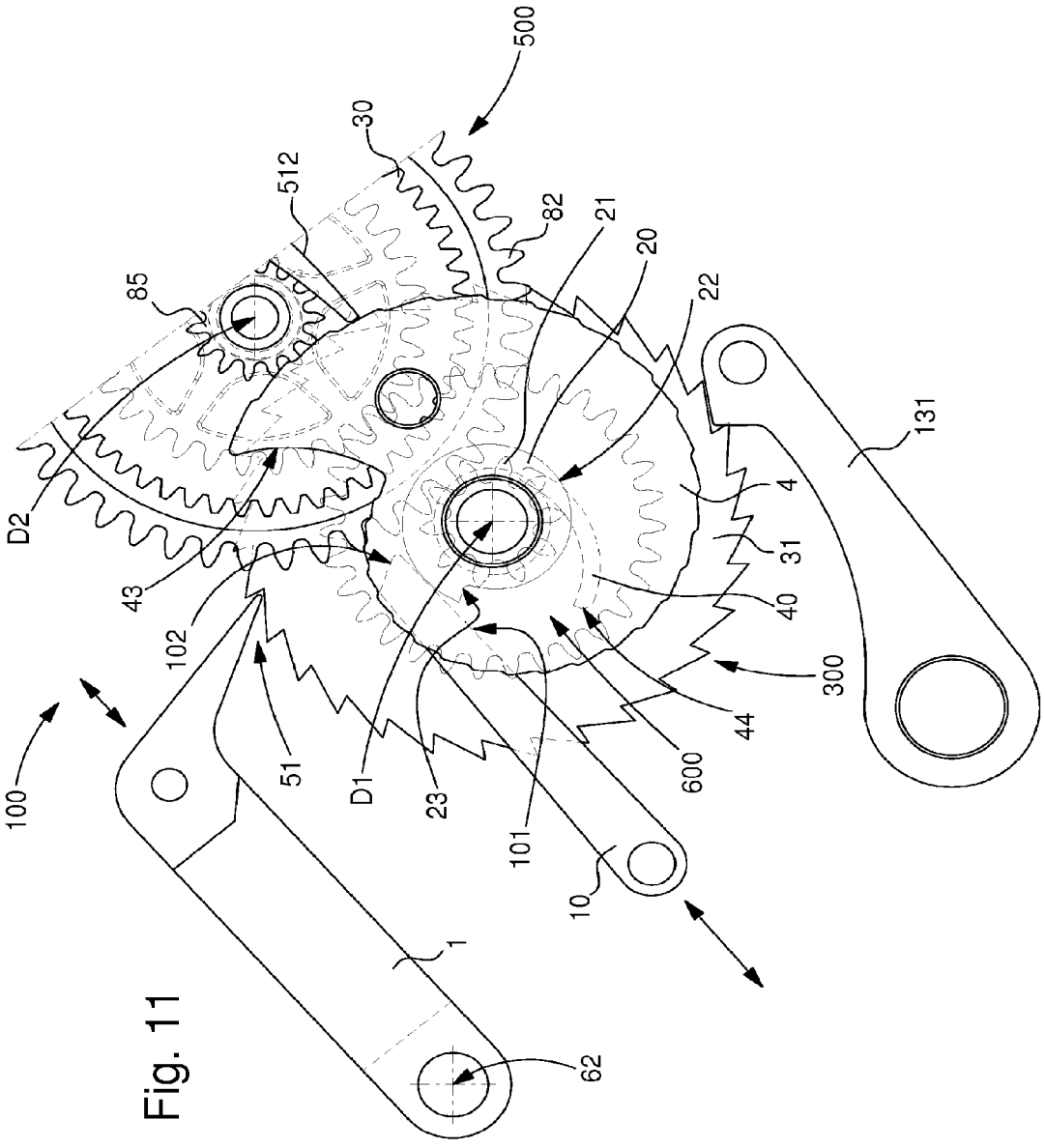

500
30
512
82
21
20
22
85
131
4
31
40
300
44
600
D2
43
102
51
D1
23
101
10
1
62
100

Fig. 11

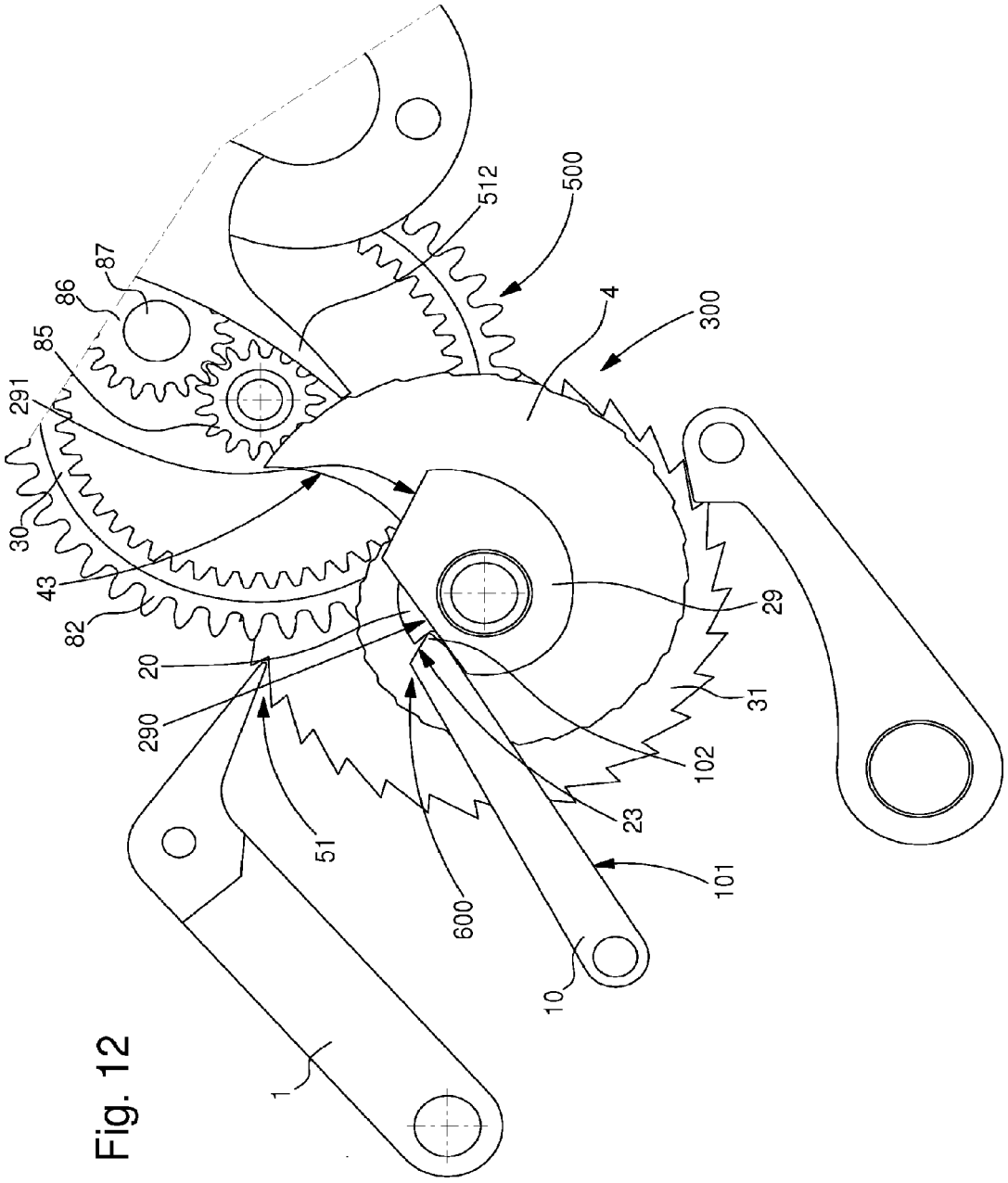

512
500
87
86
4
300
85
291
30
43
82
20
290
29
31
102
23
51
600
101
10
1

Fig. 12

PERPETUAL CALENDAR WITH A DIFFERENTIAL MECHANISM

This application claims priority from European Patent Application No. 14188600.2 filed on Oct. 13, 2014, the entire disclosure of which is hereby incorporated herein by reference.

FIELD OF THE INVENTION

The invention concerns a perpetual calendar mechanism for a timepiece including a timepiece movement arranged to control the daily release, at the moment when the date changes, of a mechanism actuating a perpetual lever comprised in said perpetual calendar mechanism.

The invention also concerns a timepiece mechanism including a timepiece movement arranged to control the daily release, at the moment that the date changes, of a mechanism actuating a perpetual lever comprised in such a perpetual calendar mechanism, and comprising a display mechanism including at least date display means controlled by said calendar mechanism.

The invention also concerns a timepiece including such a timepiece mechanism.

The invention concerns the field of calendar display mechanisms in mechanical watches, and more particularly perpetual calendar displays.

BACKGROUND OF THE INVENTION

The most conventional date timepieces are described in particular in the work entitled "Les montres compliquées" (*A Guide to Complicated Watches*) by Francois Lecoultre and edited by Editions Horlogères in Bienne.

In an instantaneous date mechanism, star-wheels for the days of the week, the month of the year and the date are all actuated by the same perpetual lever, which is pivotally mounted relative to the plate or to a bridge of the timepiece movement, and which accomplishes its date change function when the day changes, in an abrupt motion, at a precise moment, by the action of a beak and two clicks, comprised in said perpetual lever. This jump is performed around midnight.

This perpetual lever is returned by a spring to a rest position where one of its beaks abuts on a first sector of a month cam, carried by a month star-wheel with 12 teeth which completes one revolution per year, or a star-wheel with forty-eight teeth completing one revolution in four years. The radius of this month cam is representative of the number of days in the month concerned, either in the form of a notch of greater or lesser depth, or in the form of a portion that protrudes to a greater or lesser extent.

This perpetual lever is made to pivot abruptly by a wheel, which is connected to the movement and completes one revolution in 24 hours, carrying a pin for driving a heart-piece against a roller mounted on a lever returned by a spring. When the heart-piece passes a tip, this triggers the abrupt motion of a finger which drives a beak of the perpetual lever.

During its pivoting motion, the perpetual lever moves away from the month cam, and returns to abut thereon at the end of its motion, either in the same position, if pivoting occurs during the month, or to abut on the sector next to the first sector of the month cam, if the latter pivoted when actuated at the time of a change of date.

Another beak of the perpetual lever controls the pivoting of a day-of-the-week star-wheel. Since the sequence of days is perpetual, no particular mechanism is required, since it is sufficient to increment the position of this star wheel by one step.

The pivoting of a thirty-one star-wheel with thirty-one teeth is achieved via a first thirty-one click, which is pivotally mounted on the perpetual lever and whose pivoting is limited by a pin fixed to said lever. This thirty-one star-wheel pivots integrally with a first cam and a second cam both of which are snails.

The first snail cam is arranged to cooperate with a first feeler-spindle comprised in a pivoting month lever, returned towards said first cam by a spring. The function of this first cam is to cause the month lever to drop at the appropriate time. The month lever includes for this purpose, opposite the feeler-spindle, a second feeler-spindle arranged to cooperate with the month star-wheel with 12 teeth, and to push said month star-wheel by one tooth when the feeler-spindle drops from the large radius to the small radius of the snail.

The second snail cam includes a single notch, against which a second click acts, called the month-end adjustment click, carried by the perpetual lever, and rests thereon via a spring, and this second click only functions for months of less than 31 days.

At the end of a February with 28 days, the beak of the perpetual lever is in the deepest notch of the month cam, and, during the change from the 27th to the 28th of the month, the second click engages in the notch of the second snail cam. This particular setting of the perpetual lever allows the second click to drive four teeth of the thirty-one star wheel together, when the perpetual lever jumps around midnight on the 28th of the month. Simultaneously, the first snail cam actuates the pivoting of the month lever, which drives the month star wheel, and thus the month cam, to pass to the sector for the next month, which in this case is March. Consequently, the perpetual lever takes a new rest position during the month of March, which is such that the drop of the second click is delayed by four days. Thus, from the 28th March to the 1st April, this second click only drives one tooth of the thirty-one star wheel at a time.

Likewise, the notch of the month cam for the months of thirty days is arranged so that the second click drives two teeth of the thirty-one star wheel on the evening of the 30th of the month.

Likewise, the notch of the month cam for the months of February with 29 days in leap years is arranged so that the second click drives three teeth of the thirty-one star wheel on the evening of the 29th of the month.

This tried and tested system requires two clicks to ensure the proper operation of the instantaneous perpetual date mechanism.

CH Patent Application No. 660440A3 in the name of DUBOIS & DEPRAZ SA discloses a perpetual calendar mechanism which includes a large lever driven by the movement and which includes five fingers and one click. This click abuts on the periphery of a snail cam fixed to a thirty-one day wheel. Said wheel carries an actuating finger able to cooperate with a forty-eight month wheel. A first finger, formed by one end of the lever, is located on the path of an actuating finger, which can be driven by a pin carried by the twenty-four hour wheel. This actuating finger carries a convex dorsal part forming a cam, which actuates said perpetual date mechanism. In leap years, a finger enters into contact with a lever comprised in a leap year cam. A third finger cooperates with a twelve month cam. A fourth finger forming a drive beak cooperates with the toothing of a thirty-one day wheel carrying the snail cam, said fourth finger works every day, whereas the click carried by the

lever only works at the ends of the months. A fifth finger forming a second drive beak cooperates with a seven day star wheel. Due to this construction, disruptions are different depending on whether they occur for days with one jump (from 1st to 27th) or days with several jumps (28th to 31st). Consequently the torque is used irregularly and the behaviour of the mechanism differs according to the length of the month in progress.

EP Patent Application No 2503411 in the name of MONTRES BREGUET SA describes a calendar mechanism for a timepiece, which includes a movement arranged to control, once a day, the pivoting motion of a perpetual lever comprised in said calendar mechanism, said mechanism comprising means for of driving a perpetual twelve cam, which includes twelve sectors for the successive months, of different radial dimensions according to the duration of each month, and which completes one revolution per year, characterized in that said mechanism has a single click and includes a single click finger, hinged to said perpetual lever and arranged to cooperate directly with a toothing comprised in a thirty-one ratchet wheel which pivots integrally about a pivot axis of a thirty-one snail cam directly or indirectly controlling a calendar display means, and a second cam determining the position of a countdown mechanism arranged to adjust the duration of cooperation between said click finger and said wheel according to the current month and the current day of the month and to determine each day the number of teeth of said wheel to be actuated, and said countdown mechanism measuring the duration of the current month on said perpetual twelve cam and according to the position of a pin comprised therein, allowing, limiting or preventing the cooperation between a beak of said click finger and said thirty-one ratchet wheel.

EP Patent Application No 1349020 A1 in the name of ROGER DUBUIS discloses a calendar timepiece with a large format display and instantaneous jump mechanism, including a time indicator train, and calendar wheel set including a wheel with thirty-one teeth, a units wheel with thirty teeth plus a space corresponding to one tooth for driving a units pinion with ten teeth and a wheel with four teeth for driving a tens star-wheel with four teeth, an annual cam integral with a wheel with twelve teeth, and drive means connected to the time indicator train for driving the calendar wheel set by one revolution per month and the annular cam by one revolution per year, in which the calendar wheel set is integral with a correction element, and the drive means include an instantaneous jump cam integral with a wheel connected to the time indicator train to complete one revolution per day, a drive lever equipped with a retractable drive finger, elastic means pressing said drive lever against the instantaneous jump cam, a correction lever including a retractable drive finger in mesh with said correction element, a feeler-spindle intended to detect the position of said annual cam, and elastic means for connecting these levers to each other, to place the retractable drive finger of the correction lever selectively in mesh with the correction element as a function of the annual cam position detected by the feeler.

EP Patent Application No EP1524564 A1 in the name of ROTH & GENTA describes a timepiece including an annual or perpetual calendar display mechanism, including at least one month cam wherein the mechanism further includes a movable element for indicating the number of days in the month, which can be moved with respect to at least one fixed indicator element and a connection for connecting said movable indicator element to the month cam, so that, during each month, this movable element for indicating the number of days in the month occupies, with respect to the fixed indicator element, a position characteristic of that of the month cam.

SUMMARY OF THE INVENTION

The invention proposes to create an extremely reliable perpetual calendar mechanism, that is easy to insert in place of a conventional calendar mechanism, with few structural modifications.

To this end, the invention concerns a perpetual calendar mechanism for a timepiece according to claim **1**.

The invention also concerns a timepiece mechanism according to claim **7**.

The invention also concerns a timepiece including such a timepiece mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the invention will appear upon reading the following detailed description, with reference to the annexed drawings, in which:

FIG. **1** shows a schematic top view (with a transparent left portion of the Figure illustrating a countdown mechanism cooperating with a differential mechanism) of a perpetual calendar mechanism according to the invention, where operating fingers are shown in two positions, at rest and actuated.

FIG. **2** shows a schematic partial cross-sectional view of a detail of the mechanism of FIG. **1**, around a day axis and around a differential axis.

FIG. **3** shows a schematic, partial, perspective, top view of the mechanism of FIG. **1**.

FIG. **4** is a similar view to FIG. **3**, but rotated through 180°.

FIG. **5** shows a schematic, partial, perspective, bottom view of the mechanism of FIG. **1**.

FIG. **6** shows a schematic, partial, perspective, bottom view of a detail of the countdown mechanism including a month-end adjustment mechanism, comprised in the mechanism of FIG. **1**.

FIG. **7** is a similar view to FIG. **3**, from a different angle.

FIG. **8** is a similar view to FIG. **5** but rotated through 180°, and from a different angle, close to a side view.

FIG. **9** is a similar view to FIG. **7**, from another angle and after removal of a lifting-lever.

FIG. **10** is a similar view to FIG. **7** from at a different angle.

FIG. **11** is a similar top view to FIG. **6**, in another relative angular position of the cams of the month-end adjustment mechanism and of the daily countdown mechanism comprised in the mechanism of FIG. **1**.

FIG. **12** is a top view of a variant wherein the month-end adjustment mechanism includes a surprise-piece.

FIG. **13** is a plan view of a four year cam with 48 sectors.

FIG. **14** is a block diagram showing a timepiece, notably a watch, including a timepiece mechanism which in turn includes a timepiece movement and one such perpetual calendar mechanism.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The invention presents a date mechanism which is easier to arrange in a timepiece than known mechanisms, and in particular so that this mechanism can be arranged in a peripheral area of the watch, less congested by the complications.

The invention is applicable to a calendar display that may or may not be retrograde or instantaneous.

It is devised to be easily incorporated in an existing mechanism, to convert an ordinary date mechanism into a perpetual calendar mechanism.

The invention concerns a perpetual calendar mechanism **100** for a timepiece **1000**, which includes a timepiece movement **200** controlling the movement of this perpetual calendar mechanism **100**.

This perpetual calendar mechanism **100** includes various lifting-levers and other levers, the form of which is shown merely by way of illustration here, and which is essentially dictated by the other complications comprised in the timepiece, and by the requirement to prevent any interference, which may result in more complex forms than required for the actual functions.

Likewise, it should be understood that the invention can be adapted to any desired periodicity. Those skilled in the art know how to transpose the daily periodicity set out in detail here to other time periods. Likewise, the invention may be used for particular calendars, by replacing the control members described herein, which have 12 months per year of 28 to 31 days, with other control members having a number of different periods, and amplitudes of different duration, for example for lunar or other calendars.

In a known manner, notably from EP Patent Application 2503411 by the same Applicant, whose content is incorporated herein by reference, movement **200** is arranged to cause, once per day, a pivoting motion of a perpetual lever **2**, comprised in perpetual calendar mechanism **100**. In a preferred embodiment, as shown in the Figures, perpetual calendar mechanism **100** includes a mechanism for adjusting the duration of the month of February for normal or leap years, or, in another variant, additionally, for common end-of-century years.

Perpetual calendar mechanism **100** according to the invention combines a calendar mechanism **700** arranged to determine the duration of the current month, and which is updated at each current month change by a daily countdown mechanism **300**, and a differential mechanism **500** which is arranged to control, each day at the moment that the date changes, the motion of the daily countdown mechanism **300** based on information taken both from daily countdown mechanism **300** and from calendar mechanism **700**.

More specifically, the perpetual calendar mechanism **100** includes a calendar mechanism **700**, a daily countdown mechanism **300** which includes a month-end adjustment mechanism **600**, and a differential mechanism **500**, wherein the calendar mechanism **700** is arranged to determine the duration of the current month and is updated at each current month change by daily countdown mechanism **300**, and wherein the differential mechanism **500** is arranged to control, each day at the moment that the date changes, the motion of a wheel set of the month end adjustment mechanism **600**, based on information on the current day of the month taken from daily countdown mechanism **300**, and information on the current month duration taken from calendar mechanism **700**.

Calendar mechanism **700** preferably includes the usual components, and in particular a perpetual twelve cam, referred to hereafter as the "month cam" **9**, which pivots about a month axis D**4** and which can adopt several different forms:

- either, as shown in FIGS. **1** to **12**, a cam including twelve sectors corresponding to the successive months and of different radial dimensions according to the duration of each month, which makes one revolution per year, and which is combined with a leap year cam **79** carried by the cam, to determine the duration of the month of February in the current year;
- or, as seen in FIG. **13**, a four year cam which includes 48 sectors corresponding to the successive months over a period of four years including a leap year;
- or another form.

This month cam **9** is driven by the perpetual calendar mechanism **100** itself, as will be explained hereinafter, and completes one revolution per year.

In a variant using a leap year cam, month cam **9** is coaxial on month axis D**4** with a leap year wheel having four teeth, and with a ratchet wheel having twelve teeth. Month cam **9** carries the leap year cam, such as a Maltese cross or similar, the pivoting of which is controlled by the leap year wheel with four teeth. The assembly formed by month cam **9** and the leap year wheel carries or drives a month display indicator.

Month cam **9** pivots integrally with a month ratchet **69**, which is held in position by a jumper spring **89**. The month cam **9** seen in the Figures, is a simplified didactic representation illustrating a series of different paths corresponding to durations of 28/29/30/31 days, shown encircled in FIG. **1**. Naturally, calendar mechanism **700** may incorporate a conventional month cam, with the normal sequence of months and month duration adjustment.

Calendar mechanism **700** also includes, in a known manner, a lifting-lever **12** which pivots about an axis D**5**, and which is returned by a spring (not shown in the Figures). This lifting-lever **12** carries a feeler-spindle **512** which follows the profile **42** of a date snail cam, referred to here as the "thirty-one cam" **4**, comprised in daily countdown mechanism **300**, which will be described in detail below. This feeler-spindle **512** is arranged to perform an abrupt jump, at each change of month, under the action of thirty-one cam **4**, upon the passage of a radial ramp **43** comprised in its profile **42**. This lifting-lever **12** also carries a hook **8**, which is arranged to exert traction, at the change of month, on month ratchet **69**, to cause it to advance by one step.

This lifting-lever **12** also carries a rack **912** for operating a calendar display indicator **412**, forming part of display means **400** of timepiece **1000**.

Lifting-lever **12** thus continuously displays the date, its feeler-spindle **512** resting on the periphery of thirty-one cam **4**. At the end of the month, feeler-spindle **512** jumps over a radial ramp **43** of thirty-one cam **4**, which causes a pivoting motion of month ratchet **69**, at the maximum travel of lifting-lever **12** about its axis D**3**, in order to exert traction. The pivoting of month ratchet **69** causes the pivoting of month cam **9** which is integral therewith.

Daily countdown mechanism **300** includes, at the interface with a timepiece movement **200**, a perpetual lever **2**. Perpetual lever **2** pivots with respect to the plate or a bridge of timepiece **1000**, and movement **200** causes, once per day, an abrupt pivoting of perpetual lever **2**, which is returned by a spring to a rest position when it is not driven by movement **200**.

In a particular embodiment, perpetual calendar mechanism **100** is an instantaneous date mechanism by means of the abrupt daily action, at midnight, of an instantaneous mechanism arranged to cause the instantaneous pivoting of perpetual lever **2**.

In a first example of kinematics, the daily cooperation of perpetual lever **2** with a finger of a twenty-four hour wheel of movement **200** pivots the lever once per day, one of the arms thereof actuating a seven star-wheel positioned by a jumper spring, for the display of the day of the week.

In second example of kinematics, the instantaneous mechanism includes a barrel which carries a plurality of pins, each arranged to interact with a feeler finger comprised in the perpetual lever, in order to pivot said lever instantaneously. Thus, perpetual lever **2** pivots, each day at midnight, under the action of a pin that acts on the feeler finger of perpetual lever **2**. Thus, the invention frees the period from 2200 hours to 2400 hours, which is usually reserved for changing the date in calendar timepieces, and during which other operations are not recommended or prohibited.

The daily countdown mechanism **300** includes a main finger **1**, which is hinged, at a pivot **62**, to one end of perpetual lever **2**. This main finger **1** is arranged to cooperate, during the daily pivoting of perpetual lever **2**, with a toothing comprised in a ratchet wheel, referred to as the "thirty-one ratchet wheel" **31**. This thirty-one wheel **31** pivots integrally about a day axis D**1**, with a thirty-one snail cam **4**. Main finger **1** is returned by a spring (not shown in the Figures).

Each day, main finger **1** rotates thirty-one wheel **31** by one step, via a beak **51** comprised therein, until the 28th of the month. At the end of the month, the correction varies depending on the current displayed month.

In a particular embodiment, main finger **1** is curved between pivot **62** and its beak **51**.

Main finger **1** always has the same travel.

In a particular and preferred variant, thirty-one wheel **31** is a non-retrograde wheel that rotates continuously, the invention can then be used for a retrograde or non-retrograde calendar. In the case of a retrograde display, this function is performed downstream of thirty-one wheel **31**.

As explained above, the thirty-one cam **4** has snail-shaped periphery, with a radial ramp **43**. Feeler-spindle **512** of lifting-lever **12** feels, each day, the position of the day on this outer periphery, and the rotation of lifting-lever **12** updates date display indicator **412**.

According to the invention, to determine every day the number of teeth of thirty-one wheel **31** that require actuation, daily countdown mechanism **300** includes a month-end adjustment mechanism **600**, which is arranged to adjust the duration of cooperation between main finger **1** and thirty-one wheel **31** as a function of the current month and the current day of the month.

This month-end adjustment mechanism **600** includes, in a particular non-limiting embodiment, seen in FIGS. **1** to **12**, an additional cam **20**, which is a movable adjustment cam, coaxial with thirty-one cam **4** and with thirty-one wheel **31** about day axis D**1**, and whose angular deviation varies with respect to thirty-one wheel **31**, and determines the number of days adjustment to be made, for months of less than 31 days.

This additional cam **20** is arranged to cooperate with an additional finger **10**, comprised in month-end adjustment mechanism **600**. This additional finger **10** pivots on perpetual lever **2** which pushes it once per day, in the same manner as main finger **1**, and it also always has the same travel.

Thirty-one cam **4** and additional cam **20** are both snail-shaped cams, increasing in the same direction. Each of them includes an steep radial ramp, respectively **42** and **43**.

Additional finger **10** is arranged to control the date adjustment at the end of the month, according to the date and duration of the current month, by driving the appropriate number of teeth of thirty-one wheel **31**.

Main finger **1** performs the perpetual calendar actuation function, in cooperation with additional finger **10** and thirty-one wheel **31**.

The last normal day of each month is the 28th of the month.

On the evening of the 28th, month-end adjustment mechanism **600** must perform certain actions:

- if the month has 28 days, an adjustment of four teeth must be made in order to jump to the first day of the following month, in this case March;
- if the month has 29 days, an adjustment of three teeth must be made in order to jump to the first day of the next month, in this case March;
- if the month has 30 days, an adjustment of two teeth must be made in order to jump to the next month;
- if the month has 31 days, a normal jump of one tooth is made.

Thus the motion ensuring the appropriate jump must be communicated to additional cam **20**.

To achieve this, differential mechanism **500** of the invention operates daily countdown mechanism **300** based on information taken both from daily countdown mechanism **300** and from calendar mechanism **700**. More specifically, differential mechanism **500** is a differential mechanism arranged to control the angular position of additional cam **20**, as a function of the positions of month cam **9** and thirty-one cam **4**, or of thirty-one wheel **31**, which amounts to the same thing since the last two are integral with each other.

In short, according to the invention, daily countdown mechanism **300** is controlled by a differential mechanism **500** between month cam **9** and thirty-one cam **4**.

This mechanism differs from the prior art of the aforecited EP Patent Application Nos 1349020 A1 and 1524564 A1, in that, in the first document a differential mechanism forms a simple multiplier, and in the second, a differential mechanism is concerned only with managing the month of February. In the present invention, differential mechanism **500** controls the motion of movable date adjustment cam **20**, each day of each month when the date changes.

To determine the number of days in the current month, perpetual calendar mechanism **100** includes, in differential mechanism **500**, a reader lifting-lever **3**, which includes a reader feeler-spindle **53** for measuring the duration of the current month on month cam **9**.

This reader feeler-spindle **53** is positioned, according to the current month, on a radius Rm with respect to month axis D**4**. This radius Rm is variable, and depends on the number of days in the month concerned.

At each change of month, the rotation of month ratchet **69** causes the rotation of month cam **9** which is integral therewith, so as to present, facing reader feeler-spindle **53**, the radius Rm that corresponds to the next month.

According to the invention, this reader feeler-spindle **3** forms a first input of differential mechanism **500**.

This differential mechanism **500** is, in a non-limiting manner, a planetary gear differential. It includes, mounted to pivot about a differential axis D**2**:

- a main arbor **84**, the lower part of which is integral with an axial wheel **83**. This axial wheel **83** meshes with a drive wheel **92** coaxial on day axis D**1** with thirty-one wheel **31** and integral therewith;
- the upper part of main arbor **84** carries an axial pinion **85**;
- a toothed planetary carrier plate **82**, mounted for free rotation about a shoulder of main arbor **84**. Planetary carrier plate **82** meshes via its toothing with an additional pinion **21** integral with a movable date adjustment cam, said additional cam **20** being mounted to pivot on day axis D**1**. This additional cam **20** is

arranged to cooperate, in certain angular positions thereof, in abutment with additional finger **10**;

toothed planetary carrier plate **82** carries, off-centre, a planetary arbor **87**;

planetary arbor **87** carries, mounted for free rotation, a planetary pinion **86**, which meshes, on the one hand with axial pinion **85** of main arbor **84**, and on the other hand with a toothed crown **30**;

this toothed crown **30** is integral with reader lifting-lever **3**, and forms therewith a component in the form of a digit **6**, the end of whose tail is reader feeler-spindle **53**. This toothed crown **30** only meshes with planetary pinion **86** which ensures the centring thereof with respect to differential axis D2.

The second input of differential mechanism **500** is formed by thirty-one wheel **31** positioned by main finger **1**.

The output of differential mechanism **500** is formed by an additional cam **20**, controlled by the induced motion of planetary carrier plate **82**.

Differential mechanism **500** is reversible, and the inputs or outputs can be switched. This is the particular case where, when perpetual lever **2** imparts a motion to main finger **1**, and to additional finger **10**, the latter interferes with additional cam **2**, thus imparting a pivoting motion to planetary carrier plate **82**, which becomes an input of differential mechanism **500**, the output is then axial wheel **83**, which drives thirty-one wheel **31** by imparting thereto the pivoting motion required in order to jump the correct number of teeth.

Radial position Rm of reader feeler-spindle **53** thus determines, each month, a particular angular position of toothed crown **30**.

The combination of this angular position of toothed crown **30** on the one hand, and of the angular position of axial wheel **83** directly linked to that of thirty-one wheel **31** on the other hand, determines the position of arbor **87** which rolls in toothed crown **30** while meshing with axial wheel **83**, and thus determines the angular position of planetary carrier plate **82**, and thus of the additional cam **20**, which is integral with additional pinion **21**, controlled in rotation by planetary carrier plate **82**.

In short, the planetary wheel of the differential mechanism takes the information from the month cam, instead of the large lever used for this purpose in conventional perpetual calendar mechanisms.

Additional finger **10** is arranged to drive thirty-one cam **4**, in certain angular positions of thirty-one cam **4**.

Again, this is to prevent inadvertent corrections being made during the month. To this end, the month-end adjustment mechanism **600** also includes a safety mechanism, arranged, in certain angular positions of thirty-one cam **4** and of thirty-one wheel **31**, to allow the access of additional finger **10** to additional cam **20**, and in other angular positions of thirty-one cam **4**, to prevent the access of additional finger **10** to additional cam **20**.

More specifically, in a simple and advantageous embodiment, seen in FIGS. **1** to **11**, thirty-one cam **4** includes, projecting over one of the faces thereof, here on the lower part facing thirty-one wheel **31**, a deviator element **40** with a particular contour, forming this safety mechanism.

Depending on the angular position of thirty-one cam **4**, this deviator element **40** allows or prevents the access of tip **102** of additional finger **10** to profile **22** or to radial ramp **23** of additional cam **20**.

Indeed, in certain positions, deviator element **40** repulses the lower surface **101** of additional finger **10**, preventing the access thereof to profile **22** of additional cam **20**. The axial motion of additional finger **10** imparted by perpetual lever **2** then has no effect on the angular position of additional cam **20**, of its additional pinion **21** and of planetary carrier plate **82**.

On so-called normal days, from the first to the 27th of the month, other than those at the end of the month, the adjustment finger **10** never meets cam front **23**, it slides over the profile of additional cam **20**, or on a flat portion of deviator element **40** which is tangential to the external profile of additional cam **20**. The deviator element **40** thus moves away adjustment finger **10** to let additional cam **20** rotate in any direction, forwards or backwards, without contact. In the case where front **23** of additional cam **20** moves backwards at the change of month, deviator element **40** thus prevents additional finger **10** making an adjustment during the change to the next day: for example, the date is prevented from being inadvertently changed from the first to the third of the month.

On the days at the end of the month, adjustment finger **10** meets cam front **23** and pushes it; in doing so, it rotates planetary carrier plate **82** of differential mechanism **500**, and therefore rotates the ratchet of thirty-one wheel **31**; during this thrust, a distal end **44** of deviator element **40**, the furthest from day axis D1, moves away adjustment finger **10**, which can then no longer catch front **23** of additional cam **20**; only main finger **1** can push the ratchet of thirty-one wheel **31**, which, in the meantime, has rotated towards its new position which corresponds to the adjustment made.

In short, for several days, adjustment finger **10** is uncoupled by the action of deviator element **40**, which prevents it taking any action on additional cam **20**.

In the other positions, additional finger **10** may drive profile **22** of additional cam **20**, and thus rotate additional pinion **21**, thereby driving planetary carrier plate **82**.

In a particular alternative embodiment, illustrated in FIG. **12**, the thirty-one wheel **31** is integral with a surprise-piece **29**, which forms this safety mechanism, and which, in a non-limiting manner, includes a circular circumference interrupted by two flat portions **290** and **291**.

During the daily actuation of perpetual lever **2**, main finger **1** and additional finger **10**, which were on standby in an advanced position, slide backwards, over the teeth of thirty-one wheel **31** for main finger **1** and, depending on the case, over the periphery of additional cam **20** and/or over deviator element **40** for additional finger **20**.

Due to the existence of differential mechanism **500**, the angular position of additional cam **20** varies with respect to thirty-one cam **4**, since it depends both on the current day, and on the information relating to the duration of the current month taken by reader feeler-spindle **53** from month cam **9**. The angular deviation of these fronts **43** and **23** is limited to 4 days, from the date of the 28th.

With respect to a certain angular deviation between the two fronts **43** and **23**, which corresponds to a month of 31 days, differential mechanism **500** presents front **23** of additional cam **20** with an angular deviation corresponding to an adjustment jump of two teeth on the ratchet of thirty-one wheel **31**, when reader feeler-spindle **53** on month cam **9** is on a 30 day position. This angular deviation corresponds to an adjustment jump of three teeth when reader feeler-spindle **53** on month cam **9** is on a 29 day position, and to an adjustment jump of four teeth when reader feeler-spindle **53** on month cam **9** is on a 28 day position. The jump to the date of the 31st is naturally a jump of one tooth.

The invention also concerns a timepiece mechanism **800** including a timepiece movement **200** arranged to control the daily release, at the moment that the date changes, of a mechanism actuating a perpetual lever **2** comprised in such

a perpetual calendar mechanism **100**, and comprising a display mechanism **400** including at least date display means **412** controlled by calendar mechanism **700**.

The invention also concerns a timepiece **1000**, particularly a watch, including at least one such timepiece movement **800**.

The invention makes it possible to convert a conventional date mechanism into a perpetual calendar mechanism, without any substantive changes, both with a forty-eight cam and with a twelve cam.

It offers the advantage of limiting the torque draw. Indeed, in known perpetual calendars, the large lever with a double or single click covers a greater or lesser angle to correct the different months, and thus exerts greater or lesser draw on the movement. In particular, for the month of February, a conventional perpetual calendar lever has a large motion for 28 days.

There is also a considerable difference in correction mode: in a conventional perpetual calendar the pusher has to accomplish a large travel in February, and the user may inadvertently mismatch the day and the date.

The mechanism according to the invention makes it possible to prevent any errors of this type, and the user is assured that the date and month displays are accurate, since it is impossible to shift the date between the month cam and the thirty-one wheel. For example, it is impossible for the user to display 30th February or 31st June by manual correction. In some perpetual calendars, the correction is made using only the thirty-one wheel, which means that, for a coupling with a 48 cam, it is necessary to manually perform **47** turns of the thirty-one wheel to return to the correct month on the 48 cam. This advantage is therefore far from insignificant.

It is also possible to perform a correction on the month cam without having to isolate the large lever.

In short, adjustments are facilitated, the travel of the levers is reduced and the mechanism is simple, reliable and compact.

What is claimed is:

1. A perpetual calendar mechanism for a timepiece including a timepiece movement arranged to control a daily release, at a moment that a date changes, of a mechanism actuating a perpetual lever comprised in said perpetual calendar mechanism, wherein said perpetual calendar mechanism includes a calendar mechanism, a daily countdown mechanism which includes a month-end adjustment mechanism, and a differential mechanism, wherein said calendar mechanism is arranged to determine a duration of a current month and is updated at each change of the current month by said daily countdown mechanism, and wherein said differential mechanism is arranged to control, each day at a moment that a date changes, a motion of an additional adjustment cam comprised in said month-end adjustment mechanism, based on information on a current day of the month taken from said daily countdown mechanism, and information on the duration of the current month taken from the calendar mechanism.

2. The perpetual calendar mechanism according to claim **1**, wherein said differential mechanism includes a reader lifting-lever, which includes a reader feeler-spindle to measure the duration of the current month on a month cam comprised in said calendar mechanism, and wherein said reader lifting-lever forms a first input of said differential mechanism, a second input of which is formed by a thirty-one wheel comprised in said daily countdown mechanism and which is positioned by a main finger comprised in said daily countdown mechanism, and which is operated each day at the moment the date changes by said perpetual lever, to control at an output of said differential mechanism an angular position of said additional cam.

3. The perpetual calendar mechanism according to claim **2**, wherein said month-end adjustment mechanism includes an additional finger which is operated each day, like said main finger, at the moment the date changes by said perpetual lever, and which is arranged to cooperate in abutment with a radial ramp comprised in said additional cam, in certain angular positions of said additional cam.

4. The perpetual calendar mechanism according to claim **3**, wherein said month-end adjustment mechanism includes a safety mechanism, arranged, in certain angular positions of said thirty-one wheel, to allow an access of said additional finger to said additional cam, and, in other angular positions of said thirty-one wheel to prevent the access of said additional finger to said additional cam.

5. The perpetual calendar mechanism according to claim **4**, wherein said daily countdown mechanism includes a thirty-one cam which rotates integrally with said thirty-one wheel and which cooperates with a feeler-spindle comprised in a pivoting lifting-lever comprised in said calendar mechanism, and wherein said thirty-one cam includes, projecting over one of faces thereof, a deviator element forming said safety mechanism, and which, depending on the angular position of said thirty-one cam, allows or prevents the access of said additional finger to the profile of said additional cam.

6. The perpetual calendar mechanism according to claim **2**, wherein said differential mechanism is a planetary gear differential which includes:

a main arbor a lower part of which is integral with an axial wheel which meshes with a drive wheel coaxial on a day axis with said thirty-one wheel and integral therewith, the main arbor mounted to pivot about a differential axis, an upper part of said main arbor carrying an axial pinion;

a toothed planetary carrier plate, mounted for free rotation about a shoulder of said main arbor, said planetary carrier plate meshing via a toothing thereof with an additional pinion integral with said additional cam which is a movable date adjustment cam mounted to pivot on said day axis, and said planetary carrier plate carrying, off-centre, a planetary arbor which carries, mounted for free rotation, a planetary pinion, which meshes, on the one hand, with said axial pinion of said main arbor, and on the other hand with a toothed crown, which is integral with said reader lifting-lever and which meshes only with said planetary pinion which ensures a centring thereof with respect to said differential axis.

7. A timepiece mechanism including a timepiece movement arranged to control the daily release, at the moment that the date changes, of a mechanism actuating a perpetual lever comprised in a perpetual calendar mechanism according to claim **1**, and comprising a display mechanism including at least date display means controlled by said calendar mechanism.

8. A timepiece movement including a timepiece mechanism according to claim **7**.

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